REPORT

Potential Remedial Alternative for the former Plainwell Impoundment

**Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site
Kalamazoo, Michigan**

March 2003

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BLASLAND, BOUCK & LEE, INC.
engineers & scientists

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POTENTIAL REMEDIAL ALTERNATIVE FOR THE FORMER PLAINWELL IMPOUNDMENT

INTRODUCTION AND BACKGROUND

In August of 2001, the United States Environmental Protection Agency – Region V (USEPA) assumed the lead agency enforcement role on the Kalamazoo River (the River) portion of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site (the Site). USEPA proposed to address the River in a step-wise fashion to gather additional data and design and implement a series of focused remedies in each of the former impoundments in the River. The initial focus of USEPA's efforts are the former Plainwell Impoundment and the Otsego City Impoundment. In support of this approach, the agency collected supplemental sediment and soil data during 2001, and very recently initiated a Feasibility Study (FS) for this area.

The purpose of this document is to describe a potential remedial alternative that the Kalamazoo River Study Group (KRSG) recommends USEPA consider for inclusion in the FS. This alternative results from KRSG's studies of the Kalamazoo River, including the development and comparative analysis of remedial alternatives and consideration of public and agency comments on the alternative recommended by KRSG in the October 2000 draft feasibility study. KRSG is not suggesting that USEPA presumptively select this alternative.

Plainwell Impoundment Alternative Summary

The actions comprising this alternative address remedial needs and natural resource restoration in the former Plainwell Impoundment. The proposed actions will provide long-term protectiveness of human health and the environment by effectively reducing PCB loading, PCB exposure, and PCB volume and mobility. The elements of the alternative include:

- PCB source control through focused riverbank stabilization and other means;
- PCB source reduction through removal of targeted material;
- Natural resource restoration through measures to increase ecological and human use services; and
- Monitoring and maintenance.

Although the approach described below may be applicable to the other former impoundments, alternatives for those impoundments would need to be developed and comparatively analyzed in accordance with USEPA's Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (OSWER Direction 9285.6-08).

Basis of the Alternative

The KRSG suggests inclusion of this remedial alternative in the Plainwell FS based on the following findings and considerations:

- Risks to human and ecological receptors resulting from exposure to polychlorinated biphenyls (PCBs) originating from in-stream sediments in the former Plainwell Impoundment are low and are driven by the consumption of fish.
- Aside from the exposure pathways involving the aquatic environment, risk analyses indicate that there are no unacceptable risks to human or ecological receptors resulting from exposure to PCBs in the exposed former sediments in the former Plainwell Impoundment. Specifically, there are no significant risks to terrestrial receptors and recreationists.
- The principal source of PCBs to the aquatic environment within the former Plainwell Impoundment is the erosion of certain areas of unstable river banks.
- Natural attenuation of PCB concentrations in the in-stream sediments within the former Plainwell Impoundment is an ongoing, active, and measurable process.
- The results of USEPA's focused sampling of the in-stream sediments indicate that there are no sediment "hot-spots" within the former Plainwell Impoundment where focused sediment removal actions could address a large portion of the PCB mass within the sediments.
- The aquatic, riparian, wetland, and upland habitats within the former Plainwell Impoundment are valuable and functioning habitats and provide a wide range of natural resource services. Opportunities exist to improve the overall service of natural resources in the former impoundment through the implementation of ecologically sensitive remedial actions and other conservation and restoration activities.

Summary of Approach

The following elements comprise an appropriate and effective remedial alternative for the former Plainwell Impoundment:

- Source control of stabilizing of specific sections of the river banks that are eroding and contributing the majority of PCBs to the River. Source control action will stabilize eroding banks in a manner designed to maximize the net ecological benefit resulting from the trade-off between the ecological costs of construction and the benefits of significantly reducing PCB inputs to the River from the bank areas.
- Focused removal of PCB-containing, exposed former sediments in areas associated with bank stabilization. Focusing the removal activities in this manner will minimize the ecological impacts

associated with site access and construction activities. These areas will be restored and enhanced post-construction.

- A series of ecological and human use restoration projects integrated with remedial construction to enhance the natural resources and the services they provide within the former Plainwell Impoundment. These projects will focus on enhancing the overall health of the fish, avian, and mammalian communities that use the habitats in this area while improving the human enjoyment of these resources.
- Rehabilitation and long-term maintenance of the former Plainwell Dam sill.
- Monitoring environmental media before, during, and after remedial action and maintaining the stabilized banks and restoration enhancements.

The following sections provide the supporting rationale and specific design of the alternative.

ENVIRONMENTAL SETTING

The former Plainwell Impoundment extends from Main Street in the city of Plainwell to the former Plainwell Dam over a river length of approximately 1.9 miles. The former Plainwell Dam was drawn down to sill level in 1970 exposing approximately 59 acres of formerly submerged sediments. The riverbanks that were formed when the impoundment was drawn down, supply PCBs to the river.

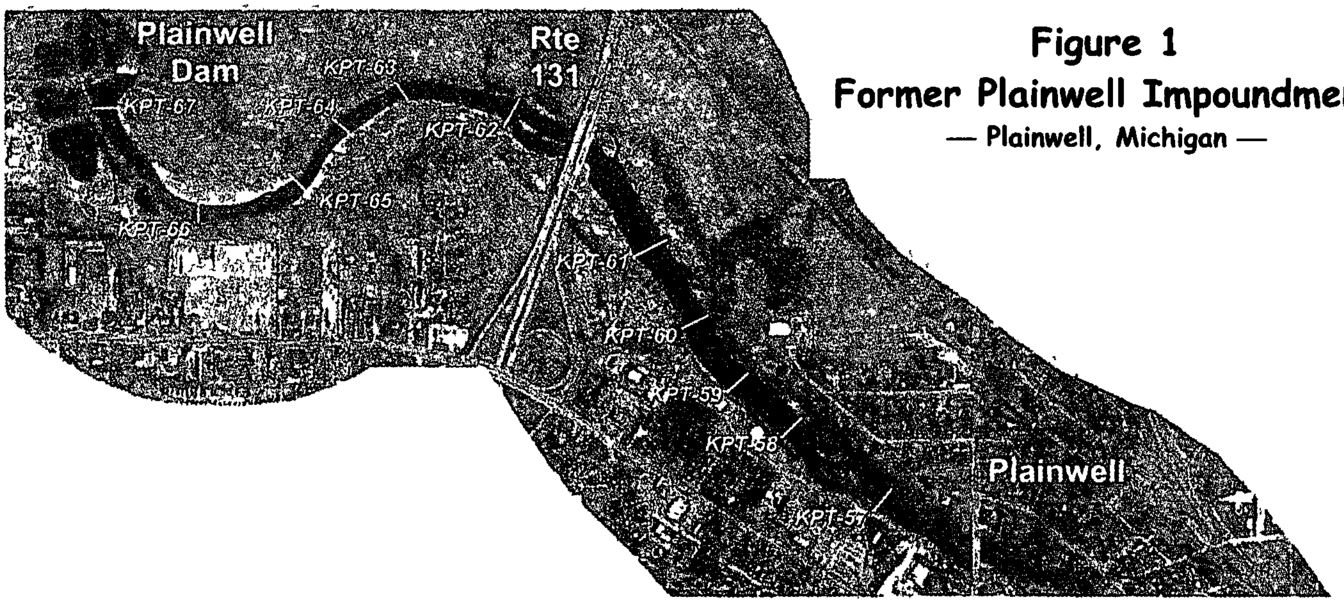


Figure 1
Former Plainwell Impoundment
— Plainwell, Michigan —

Understanding the ecology in this area is important to balancing the considerations of contaminant risk with remedy risk. The habitat within the former Plainwell Impoundment is dominated by scrub-shrub wetlands with lesser areas of herbaceous open land, shrubland, and upland forest. The riparian areas (the narrow strip of land bordering the river) within the former Plainwell Impoundment are less than 5% upland forest (compared to approximately 20% in downstream impoundments). The majority of the scrub-shrub wetland in the former Plainwell Impoundment is found on the north side of the river just upstream of the former Plainwell Dam and on the south side of the river just downstream of the Highway 131 bridge. Beyond the floodplains, there is agricultural land on the north side of the river between the Highway 131 bridge and the former Plainwell Dam. On the south side of the river within the impoundment and on both sides of the river upstream of Main St. and through the City of Plainwell, the land use is largely urbanized (i.e., commercial and industrial).

The terrestrial and wetland habitats within the former Plainwell Impoundment provide shelter and foraging areas for a wide variety of birds and mammals. Over 46 mammalian species have been identified as using the Kalamazoo River corridor habitats. The area also supports a particularly high abundance and diversity of birds (Adams et al., 1998; Brewer et al., 1991).

The aquatic habitat types found within the former Plainwell Impoundment include soft-bottom, hard-bottom, and mixed substrate streambeds; the stream bank; and the water column. These habitats provide shelter and foraging areas for a number of species including aquatic macroinvertebrates, fish, reptiles, amphibians, and benthic-feeding and piscivorous birds and mammals.

SOURCE CONTROL VIA BANK STABILIZATION

Erosion of the riverbanks within the former Plainwell Impoundment is a significant source of PCB to the sediments of the former Plainwell Impoundment. The significance of the riverbanks as a source of PCB to the river sediment is related in part to the difference in PCB levels. As explained below, the PCB levels in the exposed sediment are higher than in the submerged sediment. Another important aspect of the significance of the banks is the rate at which these deposits are eroding and sloughing into the river. Bank erosion is addressed further in the following section.

The sampling performed by USEPA in 2001 found relatively low PCB concentrations in the submerged sediment. In addition, samples of submerged sediment from the former Plainwell Impoundment collected as part of the RI conducted by KRSG show that PCB levels in surface sediment have been declining. Surface-area-weighted average PCB concentrations in surficial sediments within the former Plainwell Impoundment declined by approximately 60% between 1993 and 2000 from 4.0 milligrams per kilogram [mg/kg] down to 1.6 mg/kg. In contrast, the average PCB concentration in the exposed sediments is roughly 8 times (or more) higher. Surface-weighted-average PCB concentrations in the surface of the exposed sediments are in the neighborhood of 12-14 mg/kg, according to draft estimates from LTI Limnotech and USEPA.

When the exposed sediments erode and slough off the riverbanks, PCBs are transported into the river where they are deposited and become available for further transport downstream and exposure to the aquatic food web. If this source of PCBs and the erosion pathway were cut off, natural recovery of in-stream sediments would be expected to accelerate and further reduce PCB bioavailability and exposure, which would in turn reduce PCB levels in fish. This is an important result as PCB levels in fish are the primary risk-driver and remedial focus for the entire site. Thus, source control through reduction of PCB loading from the bank soils is the primary objective of this remedial alternative for the former Plainwell Impoundment, and would be expected to enhance natural recovery and reduce PCB concentrations in submerged sediments.

The remedial alternative outlined here would achieve the goals of reducing PCB loading and enhancing/accelerating natural recovery of in-stream submerged sediments by containing and stabilizing approximately 8,100 linear feet of riverbank within the former Plainwell Impoundment. As described below, the source control/stabilization measures would be targeted in those locations that have the potential to contribute the majority of PCB loading.

Approach to Identifying Banks for Source Control/Stabilization

The banks in the former Plainwell Impoundment targeted for stabilization were identified using both quantitative measures of bank erosion and contaminant concentrations along with qualitative measures of erodibility, vegetative cover, and adjacent habitat quality.

The potential for individual bank sections to contribute sediment and PCB load to the river was evaluated according to the set of relevant qualitative and quantitative factors. Riverbanks were classified based on type and degree of vegetative cover, estimated slope of banks, and visual evidence of ongoing erosion. Upland and near-shore land use, habitat quality, and wetland areas also were identified. These classifications were used as a qualitative indicator of bank condition and the potential for erosion of bank solids. In addition, bank slope information determined from elevation transects collected in 1999 was used as a measure of slope stability. Comparison of the 1999 transect data with earlier transect data from 1993 also provided a means for direct calculation of bank retreat rate.

PCB concentrations used for developing contaminant load estimates were based on GIS-derived maps of interpolated PCB concentration data within the former impoundment area. These maps were used to estimate both surficial and vertically-averaged PCB concentrations in the near-bank areas. In addition, estimates of the silt/clay content in the riverbanks were included in the consideration of shoreline characteristics because of the strong tendency of PCBs to sorb onto fine particles.

To identify specific areas for bank stabilization, estimates of PCB loading were developed in two different ways. First, estimates of PCB loading from the banks were developed based on transect-specific erosion rates and vertically-averaged PCB concentrations. Second, estimates of potential PCB loading were developed by applying a median bank erosion rate to all bank areas containing measurable PCB concentrations. These two measures of PCB loading were used to identify bank areas with high potential loading rates. Habitat quality adjacent to the identified banks was also considered from an implementation perspective.

Assessment of PCB Loading from Bank Erosion

PCB bank erosion loads were computed for sections of the river bank between midpoints of the former Plainwell Impoundment transects KPT-56 through KPT-67 established in the 1993/94 remedial investigation and subsequently re-surveyed in 1999 (see Figure 2 for transect locations).

The PCB concentration attributed to each section of the bank was estimated using vertically-averaged PCB concentrations from a geo-statistical kriging analysis (Figure 2) of available sediment data, including

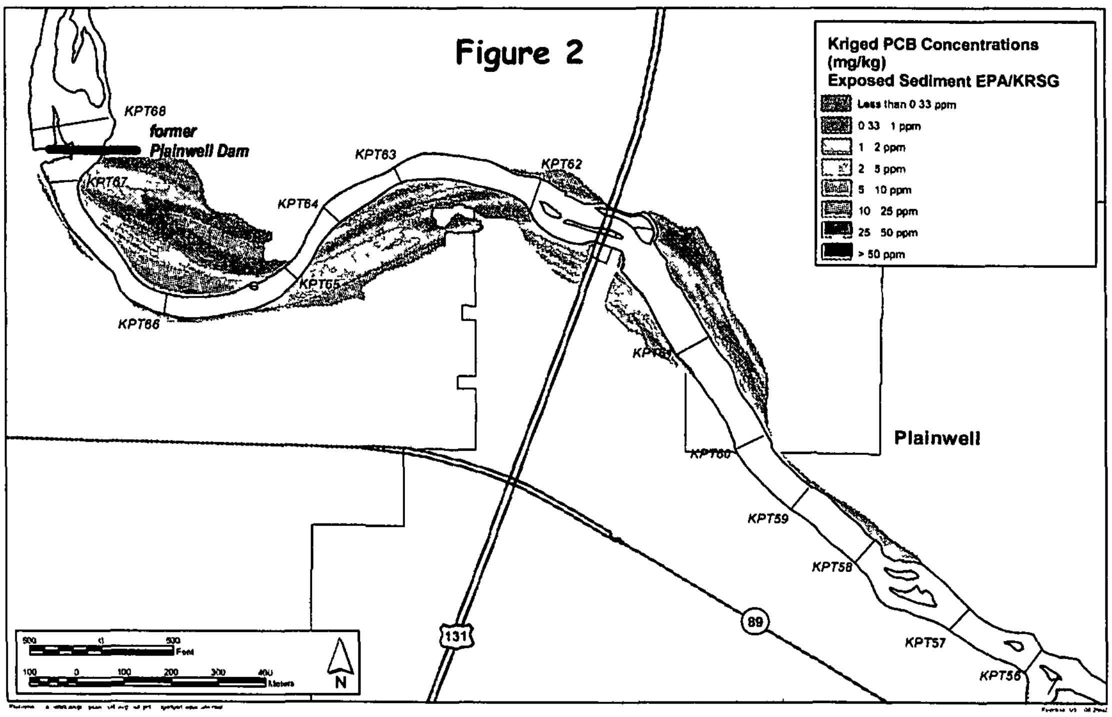


Figure 2

the most recent data collected by USEPA. (Note that the vertical averages are presented in the fifth column of Table 1.) The concentration map was "sampled" at 50 meter intervals along the banks to develop an average bank soil PCB concentration for left (south) and right (north) bank intervals. The bank length for each section was defined as the distance between transect midpoints. Bank height at each transect location was determined as the vertical distance from the toe of the bank to the top of the bank by inspection of bank profiles surveyed in 1993 and 1999. The transect-specific erosion rate was then estimated for each location based on the difference in bank locations surveyed in 1993 and 1999 (column 6 in Table 1). The survey data showed consistent evidence of bank soil loss throughout the impoundment over this six-year period, although the exact mass of soil lost at each location is difficult to precisely establish due to limitations in the survey data. Erosion pin study results, discussed in the October 2000 RI/FS Supplement report and augmented by the results provided in Attachment A, also indicate measurable bank retreat at several locations.

Table 1 -- Summary of Data for Transect Area Load Calculations

KPT	Side	Length (ft)	% of Total Length	Vertically Averaged PCB (mg/kg)	Transect-Specific Soil Erosion Rate (kg/ft/yr)	% of Total PCB Load	Median Soil Erosion Rate (kg/ft/yr)	% of Total PCB Load
67	left	700	3 6	4 7	130	14	38	7 7
	right	600	3 1	3 5	0	0 0	38	5 0
66	left	1150	5 9	1 3	88	4 2	38	3 6
	right	950	4 9	16	110	52	38	37
65	left	800	4 1	2 7	130	9 2	38	5 2
	right	700	3 6	3 0	0	0 0	38	5 1
64	left	500	2 6	0 9	130	2 0	38	1 1
	right	600	3 1	0 0	0	0 0	38	0 0
63	left	700	3 6	2 5	86	4 8	38	4 2
	right	800	4 1	0 0	0	0 0	38	0 0
62	left	1250	6 5	1 2	86	3 9	38	3 4
	right	1650	8 5	0 5	0	0 0	38	2 0
61	left	1300	6 7	4 0	29	4 7	38	12
	right	1200	6 2	2 0	57	4 2	38	5 6
60	left	700	3 6	0 0	50	0 0	38	0 0
	right	650	3 4	2 8	15	0 9	38	4 3
59	left	600	3 1	0 0	50	0 0	38	0 0
	right	550	2 8	0 9	15	0 2	38	1 2
58	left	750	3 9	0 0	50	0 0	38	0 0
	right	800	4 1	1 4	15	0 5	38	2 6
57	left	800	4 1	0 0	50	0 0	38	0 0
	right	700	3 9	0 0	15	0 0	38	0 0
56	left	350	1 8	0 0	50	0 0	38	0 0
	right	550	2 8	0 0	15	0 0	38	0 0

The calculated bank erosion rates exhibit significant spatial variability, and the data may be insufficient to confidently assign the computed bank erosion rate at each transect location to the entire bank section bounded by transect midpoints. Therefore, relative bank loading potential among bank sections was further assessed by assigning a median soil erosion rate of 38 kg/ft/year to all transects in the impoundment. The annual bank erosion PCB load was computed for each bank section using both the transect-specific erosion rate and the median erosion rate in conjunction with the local average PCB concentration and distance between transect midpoints. The relative PCB contribution of these reported lengths are presented in columns 7 and 9 of Table 1. The relative loading of PCB (e.g., percent of total PCB load) is useful in targeting areas for remediation. The total annual load of PCB estimated using the transect-specific soil erosion rates and the median soil erosion rates are 3.2 kg/year and 1.6 kg/year, respectively.

Identification of Bank Sections Targeted for Remediation

The annual PCB load computed for each bank section was expressed as a percent of the total bank load computed for the entire impoundment using both methods of computing the bank load. Similarly, the percent of total bank length in the impoundment represented by each bank section was computed (Table 1). These values were ranked based on percent load reduction and are shown as percent of total bank length remediated (remedial effort) versus percent of potential bank erosion PCB load controlled (remedial benefit) curves on Figure 3. As previously mentioned, this type of remedial effort versus remedial benefit curve provides a basis for targeting bank sections for remediation and removal to achieve a cost-effective remedial action plan that preserves existing bank character and habitat for those areas with relatively little importance to total PCB loading to the river due to bank erosion.

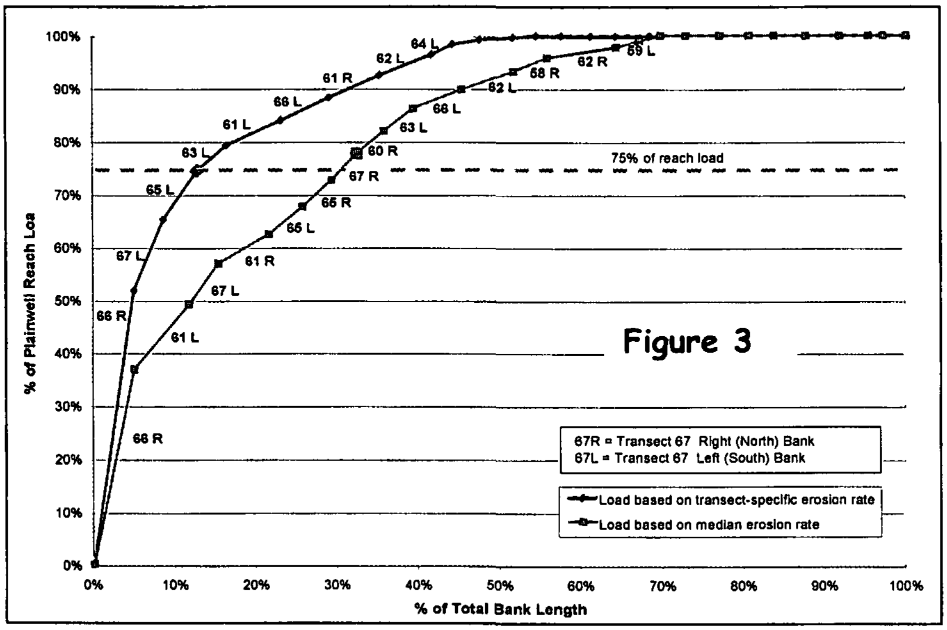
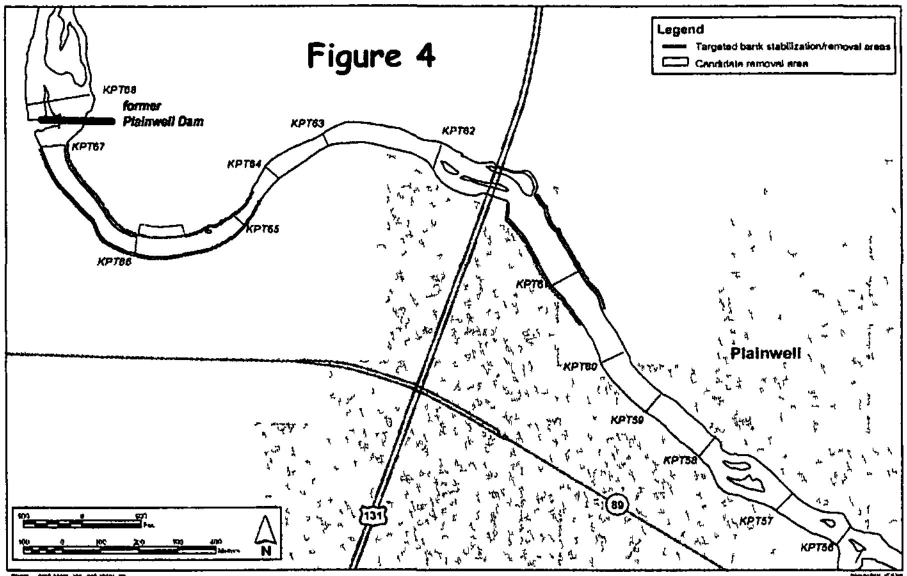


Figure 3

The cumulative percent bank load versus percent of bank length curves shown in Figure 3 show a "knee" in each curve distinguishing between those bank sections contributing a disproportionately high load to the reach from other, lower load sections. Inspection of the figure shows that based on best estimates of transect-specific erosion rates, three transects account for a total of 75% of the total bank load while representing only 13% of the total bank length. This breakpoint is indicated with an enlarged symbol and a dashed line on Figure 3. When the same 75% level of bank load reduction is extended to the loading potential curve based on median erosion rate, an additional 19% of the total bank length is added to the total area targeted for remediation. This addition represents inclusion of areas that have relatively high potential to contribute PCB load to the river based on bank PCB concentrations, even though the bank survey data indicate moderate erosion rates in these areas. When combined, the two methods identify right and left bank sections represented by KPT-61, KPT-65, KPT-67 and the right bank section represented by KPT-66 (Figure 4) These areas were selected to achieve an effective source control approach for reducing PCB loading from eroding banks The left bank at KPT-66 was also added based on bank stability considerations as remediation of bank areas immediately upstream, downstream, and across the river from this area may lead to increased scour forces along this section of the bank

In addition to sediment volume targeted for removal as part of the focused bank remediation effort described above, a candidate removal area was identified near the right bank of KPT-66 Results of USEPA's exposed sediment sampling conducted in 2001 identified this area as a primary repository of PCB mass in the system, as shown in the map of vertically averaged PCB concentrations presented in Figure 2. Removal of sediments in this area offers the opportunity to target some of the highest concentrations of PCBs on a per unit area basis with a limited scale of excavation, while minimizing the ecological impact of the removal The candidate area, shown in Figure 4, was developed to remove vertically-averaged concentrations in excess of 25 mg/kg adjacent to the bank remediation effort planned at KPT-66. Addition of this area (covering 400 feet along the length of the river bank, 100 feet back from the shoreline, down to the point where PCB concentrations are non-detect) to the proposed plan increases the total proposed removal by 6,500 cubic yards.



Based on the quantitative and qualitative factors described above, a set of targeted bank areas was identified for stabilization. The riverbanks on both sides of the river near Plainwell transects KPT 61, 65, 66, and 67 were identified for remedial action (see Figure 4, above) Taken together, controlling both known and potential erosion from these areas is expected to reduce PCB loading from the riverbanks within the former Plainwell Impoundment by approximately 85% and, importantly, limit the length of banks and nearby areas that would be significantly disrupted by construction activities. The major components of the alternative include bank stabilization, removal of exposed sediments, rehabilitation of the former Plainwell Dam sill, integration of natural resource restoration, and monitoring and maintenance.

1. Bank Stabilization Design

The proposed remedial actions for the former Plainwell Impoundment include stabilization of approximately 8,130 linear feet of riverbank and the removal of approximately 10,000 cubic yards of PCB-containing exposed former sediments adjacent to the proposed bank stabilization areas and from an area on the north side of the River just upstream of the former Plainwell Dam (near KPT 66, see Figure 2). A number of bioengineering and restoration components are included as a part of the proposed remedial actions to compensate for any potential ecological damage associated with the remedial actions. Specifically, as described previously, all bank stabilization will include an ecological enhancement component in addition to the hard substrate component necessary for source control. The ecological component will include regrading of the banks and revegetation of access roads and banks with native plant species including grasses, shrubs, and trees.

Stabilization will be accomplished by constructing temporary access roads along portions of the riverbanks, from which excavation and other construction equipment could gain access to the target areas. Once accessed, the banks will be cut back from the water's edge to reduce the slope and create more stable banks that would be less likely to erode. This would involve removal of some PCB-containing soils, which will be dewatered and stabilized for off-site disposal, as necessary. Silt curtains will be placed in the river surrounding any areas where bank excavation disturbs underwater sediments.

The regraded banks will be further stabilized using carefully selected materials to enhance the habitat value of the improved areas. River bank surfaces below water levels will be stabilized using a variety of small-diameter stone, submerged aquatic vegetation plantings, and large woody debris for fish habitat. Bioengineered measures for bank slopes above the water line will include plantings of live stakes, shrubs, and marsh vegetation, as appropriate. In areas subject to potential scour, additional protection will be provided by coir logs, soil-filled geotubes, or anchored woody debris, until native vegetation becomes established. The riparian corridor beyond the top-of-bank will also be planted and improved to conditions suited to the needs of resident wildlife. This area between top-of-bank and the access roads will be restored for beneficial use by wildlife and recreational visitors. The access road can be restored or converted to a riverfront recreational trail system.

These bioengineered features, emphasizing organic materials, are an improvement over the concepts described in the October 2000 Feasibility Study, which was criticized as being incompatible with the needs of resident wildlife. Several of the described restoration features are shown on the architectural rendering of the post-construction bank area, attached as Figure 5.

2. Removal of Exposed Former Sediments

The alternative would include removal of approximately 10,000 cubic yards of PCB-containing material from the areas along the banks that would already be disturbed by other construction activities as well as additional localized areas with relatively higher PCB concentrations that can be readily accessed from the construction access roads already contemplated for the proposed bank stabilization remedy. One such candidate removal area is located adjacent to the riverbank near Transect KPT 66 (northside). The vertically-averaged PCB concentration in this location is approximately 25 mg/kg near the shoreline, and the material could be accessed during construction of the source control/stabilization measures planned for that area.

3. Rehabilitation of the Plainwell Dam Sill

Rehabilitation of the sill and remaining superstructure of the former Plainwell Dam is another component of the alternative. Rehabilitation of the dam sill would be accomplished by installing sheet piling on the upstream side of the existing sill. The area between the sheet piling and the sill would be dewatered to allow visual inspection and resurfacing or improvement of the sill structure, if required. Any seepage or undermining of the sill structure may also be reduced by placement of clay fill or concrete. Sheet piling and fill may also be used to stabilize the earthen embankments adjacent to the dam sill. Finally, stone rip rap would be placed on areas subject to erosion during high flow periods. To assure long-term maintenance of the pool elevation within the former Plainwell Impoundment institutional controls and dam sill maintenance are included in the alternative.

4. Integrated Restoration Projects

Bank stabilization and exposed former sediment removal activities are proposed for a portion of the northern shoreline along a broad river bend just upstream of the former Plainwell Dam (see Figure 2). Subsequent to these proposed remedial activities, a mosaic of approximately five acres of floodplain, wetland (scrub-shrub and forested), and upland wooded habitat will be created in this area. This proposed project will serve to increase the complexity of the existing habitat and create higher quality foraging areas for avian and mammalian wildlife, thereby improving the abundance and diversity and overall health of species in the area. The ecological and human use features described below would also be constructed.

Fish Habitat Enhancement

Fish habitat construction would be undertaken to enhance spawning habitat and microhabitat/refugia for a variety of fish and to create foraging areas for fish. Fish habitat enhancements to be integrated with the remedial construction will: (1) optimize in-stream cover, defined as a densely vegetated stream bank down to and below the water surface, with the presence of visible snags, woody debris, and a significant amount of mixed or hard non-homogenous streambed substrate (i.e., predominated by boulders, cobbles, and gravel); (2) increase hard bottom substrate and riffle habitat where feasible; and (3) enhance existing deep pool habitats that provide critical services for many highly valued fish by adding spawning substrate and/or woody debris.

Former Plainwell Dam

Construction of a fish ladder at the former Plainwell Dam, in conjunction with the rehabilitation of the sill as described above, provides a functional alternative to complete dam removal. The construction of a fish ladder at the former Plainwell Dam would bring the River closer to a natural run-of-river system and allow fish and aquatic organisms to move between impoundments.

Recreational Amenities

Facilities would be constructed to improve access to the river for a variety of beneficial uses such as boating, hiking, biking, cross-country skiing, picnicking, and wildlife observation. The attached architectural renderings (Figures 5 through 8) and the following text briefly describe several potential human use project concepts that could be constructed at the former Plainwell Impoundment.

To improve public access and use of this portion of the river, the alternative includes a new public park, which would occupy existing MDNR-owned land near the former dam (some land acquisition may also be necessary). Most of the facilities would be constructed outside the boundary of the former impoundment water line (as shown on the attached rendering).

An existing right-of-way would be used to develop a new access road to the area, where visitors would enjoy a small complex of outdoor recreation facilities focused on the waterfront at and near the rehabilitated former Plainwell Dam sill. Parking would be made available to accommodate a variety of users including those wishing to launch (or portage) a small-draft motor boat or canoe/kayak, or use the new trail system (approximately 2 miles of new riverfront trails and upland loop trail), playground, picnic area, wildlife observation decks, or modest nature center building (with restrooms). To provide connectivity between the new trails constructed on either side of the river (i.e., restored/converted construction access roads), a small bridge would be integrated into the rehabilitation of the former Plainwell Dam sill to allow safe passage of pedestrians and bike riders across the river and afford excellent views of the river and the new fish ladder built into the dam. Ideally, these components would be eventually linked with other riverfront facilities, such as the existing waterfront features in downtown Plainwell or as part of the larger community efforts to construct a continuous and extensive riverfront trailway system (e.g., the Kalamazoo River Valley Trailway).

5. Monitoring and Maintenance

During bank restoration construction activities, monitoring would include observations to detect potential impacts to water quality. Monitoring would include daily sampling and analyses of upgradient and downgradient water samples. The results of this monitoring would be used to identify any necessary modifications to excavation procedures or silt containment systems. Monitoring, sampling, and reporting would also be implemented for activities associated with sediment dewatering, stabilization and/or transport to off-site disposal.

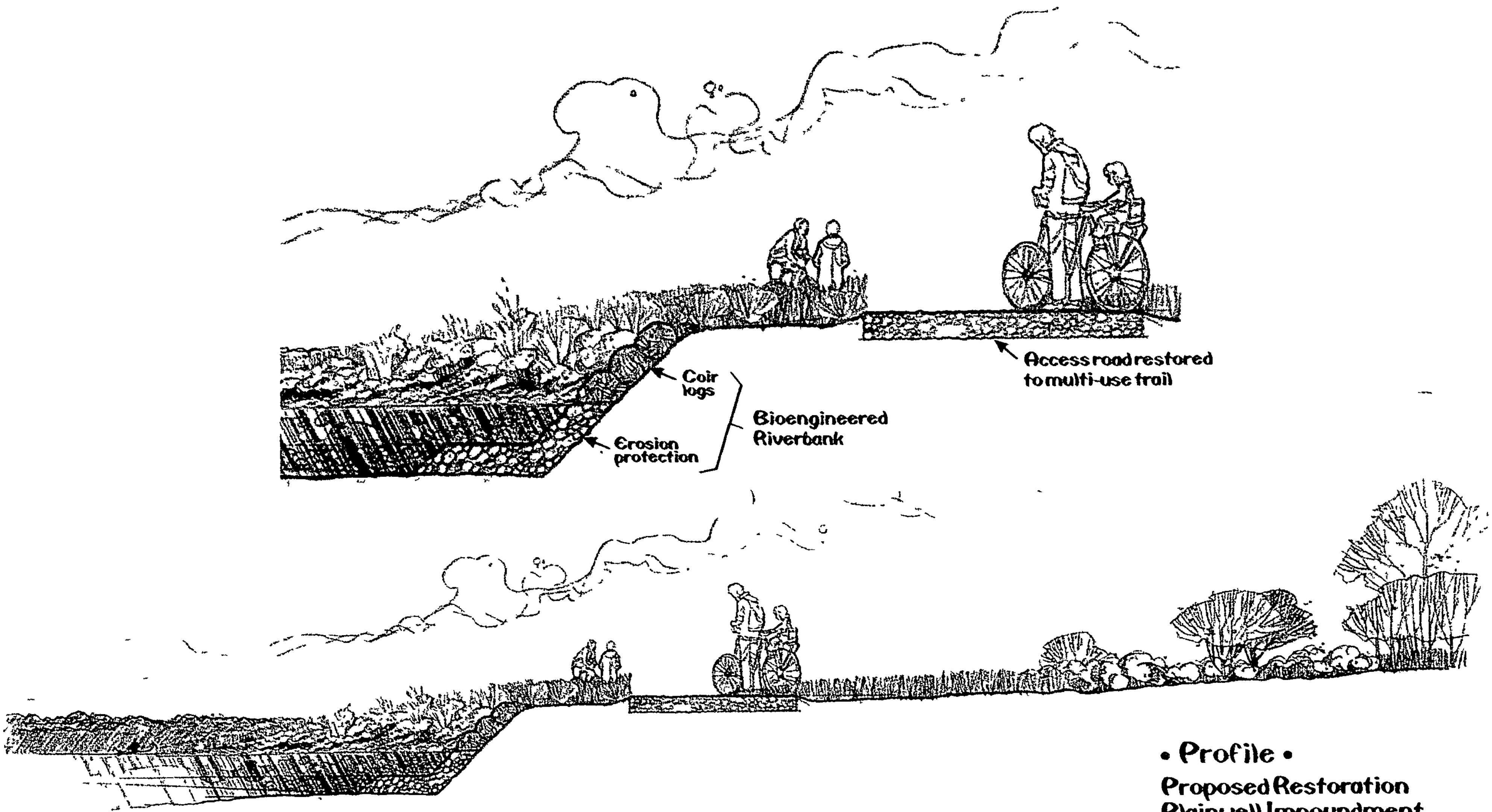
Post-construction monitoring activities would include visual observation of the restored banks, both above and below the water line. Based on these monitoring results, maintenance or replacement of bank features would be performed as necessary. This maintenance might include replacement of dead vegetation and/or disturbed or eroded soil, stone, or habitat features. Monitoring would include periodic sampling, analyses, and reporting of water and biota (caged fish) samples. It is estimated that inspection and maintenance would be performed annually for five years after construction and then every third year for the subsequent 25 years. Sampling and analyses would be performed before, during, and after construction. Erosion pins will be installed in areas where stabilization measures have not been implemented. The status of the pins will be observed at the same time the stabilized banks are monitored. Ecological habitat monitoring would be performed quarterly for three years.

Remedial Design Considerations

The foregoing conceptual design provides a specific illustration of the design approach. It should be noted, however, that as additional data become available (e.g., through a design study) the specific lengths of bank to be stabilized and soil volumes to be removed are likely to be adjusted. However, the basic concept of focusing bank stabilization and removal measures to the areas that comprise the great majority of ongoing and potential PCB losses would be the basis for the final design.

Estimated Costs of Alternative

The total estimated 30-year present worth cost associated with the implementation and monitoring/maintenance of the alternative is approximately $13.1 million. Present worth capital costs would be approximately $10 million, and long-term operation and maintenance (O&M) and monitoring costs would be approximately $3.1 million. An additional $2 million (approximately) would be invested in natural resource restoration to increase ecological and human use services. All together, this comprehensive plan to address remedial and natural resource damage needs within the former Plainwell Impoundment would cost approximately $15.1 million (30-year present worth, including contingency costs). Construction would require approximately one year.



• Profile •

Proposed Restoration Plainwell Impoundment

Kalamazoo River, Michigan

Figure 5

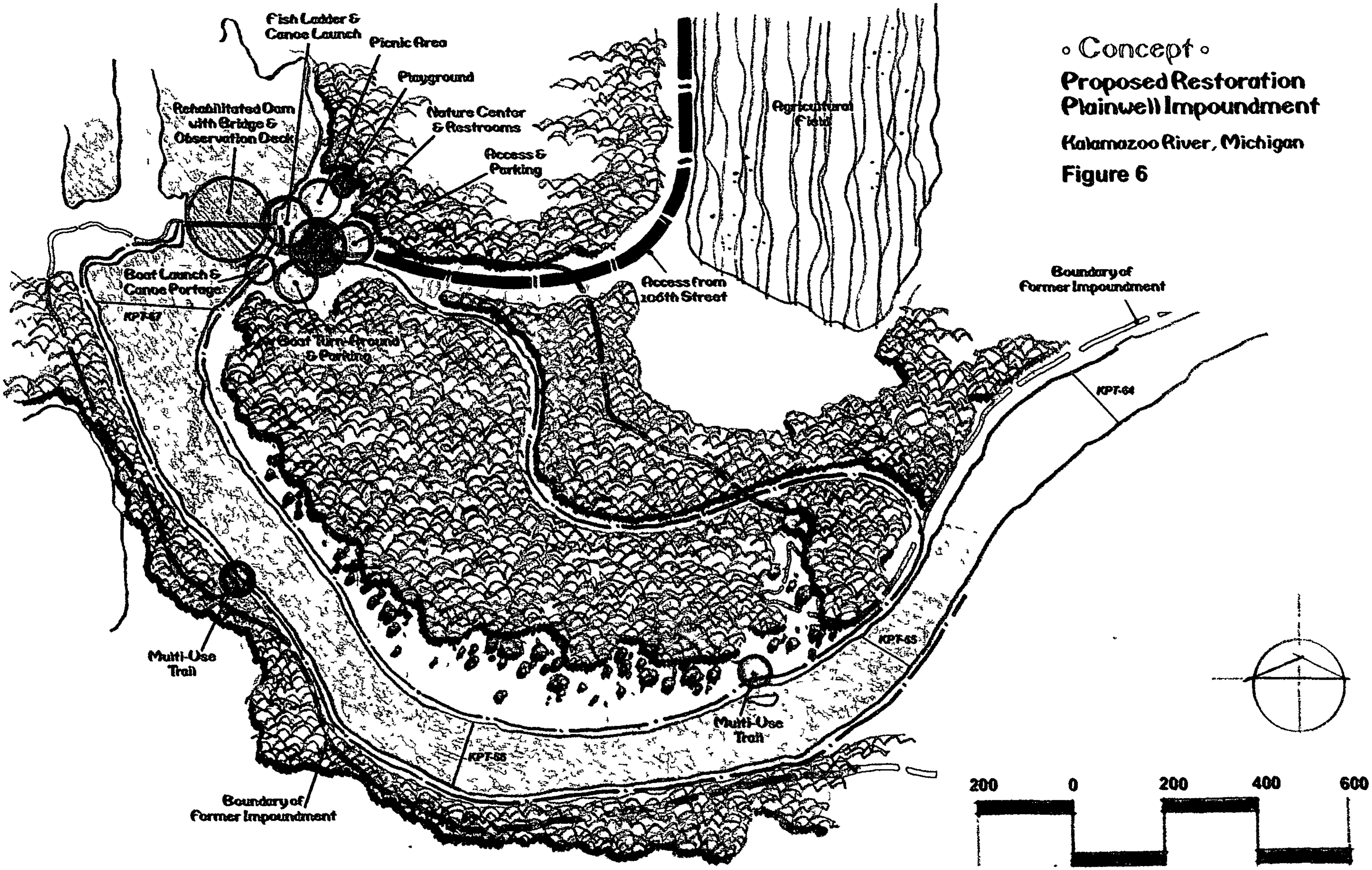
MFE.U Kalamazoo\Plainwell\Renderings\SeptRev\rev_profile.cdr (09.17.02)

◦ Concept ◦

Proposed Restoration Plainwell Impoundment

Kalamazoo River, Michigan

Figure 6



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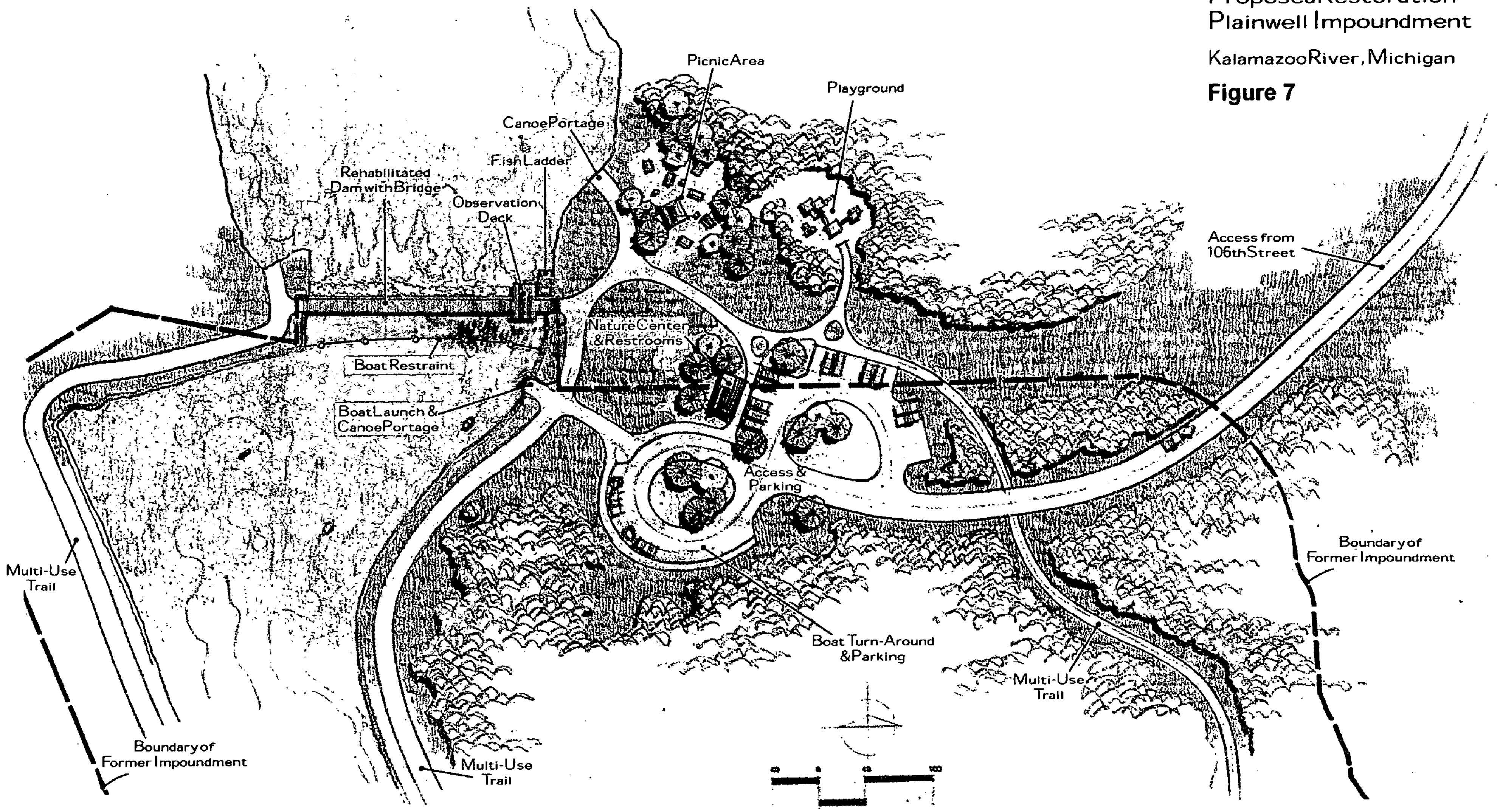
• Plan •

Proposed Restoration
Plainwell Impoundment

Kalamazoo River, Michigan

Figure 7



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• Character •

ProposedRestoration
Plainwell Impoundment

KalamazooRiver, Michigan

Figure 8

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Attachment A

Erosion Pin Monitoring Data: Fall 2000 - Fall 2002

Kalamazoo River Study Group
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

March 2003

Attachment A

Erosion Pin Monitoring Data: Fall 2000 - Fall 2002

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Table of Contents

Introduction

This document is an interim progress report presenting the results of erosion pin surveys conducted in March and October 2001 and November 2002. The erosion pin surveys were performed as part of the ongoing erosion pin study, which is designed to characterize changes along the banks of the Kalamazoo River in the former Plainwell, Otsego, and Trowbridge Impoundments. The rationale and design of the study are described in Appendix S-1 of the *Supplement to the Kalamazoo River RI/FS* (Blasland, Bouck & Lee, Inc. [BBL], 2000a).

The specific objectives of the erosion pin study are to:

- Assess changes in the channel shape and river bank configuration over time;
- Estimate rates of river bank erosion within each of the three former impoundments; and
- Estimate the volume and mass of solids as well as the mass of polychlorinated biphenyls (PCB) contributed by the banks of each former impoundment to the river on an annual basis.

This interim report presents available survey results to date and provides a brief, preliminary interpretation of these data.

To achieve the erosion pin study objectives, surveyed profiles of the river banks were established in each former impoundment corresponding to sediment sampling transects established during the 1993 Remedial Investigation (RI) work. Within each former impoundment, 3 bank profiles (straight lines about 20 feet apart and perpendicular to the river flow) were established at both ends of 5 existing sediment transects, resulting in a total of 30 erosion pin profiles per impoundment (see Figures 1, 2, and 3 for locations). Each erosion pin profile includes 12 to 13 surveyed locations profiling the river bank. The locations are marked off from the top-of-bank location, and extend in a straight line back from shore into the floodplain (to a maximum distance of 25 feet back) and into the river channel, 5 feet beyond the bottom-of-bank location. Each location was surveyed for geographic coordinates and elevation, and the locations on land were physically marked with survey pins.

To identify each erosion pin profile individually, a three-tier nomenclature was applied. The first part of the erosion pin name scheme (EP-#) refers to the 1993 sampling transect number, the second part (A or B) refers to the side of the river, and the last (X, Y, or Z) refers to the individual survey line. All "A" locations refer to the left side of the river as one faces downstream (the south side) and all "B" locations refer to the right side of the river (the north side). Profile names including an "X" always designate the downstream-most location while "Z" is always the upstream-most profile associated with any given sampling transect. For example, a profile identified as "EP-65AX" would be the most downstream survey line found in the vicinity of KPT65 on the south side of the river.

Long-term changes in the river banks are measured by periodically monitoring the elevations of each established erosion pin profile location and by monitoring the edge of the bank relative to the permanently placed erosion pins. Figure 4 shows an example of how both horizontal and vertical changes in a top-of-bank location are measured. Comparison of periodic survey results can establish erosion, deposition, or other changes in the bank profile, such as sloughing. Sloughing occurs when a steep bank fails and a portion of the upper bank soil is deposited in the river at the toe of the bank, reducing the bank slope.

Erosion pin placement, completed in the fall of 2000, is described and background information, general field information and procedures, and distance and elevation profiles are presented in the *Former Impoundment Erosion Pin Placement Report* (Erosion Pin Placement Report; BBL, 2000b). The erosion pin survey methods described here are used to conduct periodic (annual or semi-annual) surveys of the bank profiles. Three surveys have been conducted to date: March 2001 (results reported in BBL, 2001), October 2001 (results reported in BBL, 2002), and November 2002.

Survey Methods

The baseline profile (i.e. the initial profile for the bank erosion study) of the river banks was established at each erosion pin transect location and elevation during the 2000 baseline survey within the three former impoundments. In each of the three monitoring surveys, the location and elevation of each erosion pin were established by re-surveying the pin locations from the 2000 baseline survey. Consistent conventional land surveying methods were used for all survey activities, providing a horizontal accuracy of approximately 0.1 feet and a vertical accuracy of approximately 0.1 feet.

While the erosion pin placement completed in the fall of 2000 used survey benchmarks installed as part of the 1993/1994 RI, in March 2001, permanent benchmarks were installed specifically for the erosion pin study. The 2000 survey data presented in Appendix A represent recalculated elevations based on the new benchmarks. These data vary only slightly from the elevations presented in the Erosion Pin Placement Report (BBL, 2000b), but supercede those results.

During each monitoring survey, the bank locations were photographed. Plots of the bank profiles for all survey events are provided in Appendix A and bank profile survey data are presented in Appendix B. Photographs showing the surroundings at the erosion pin transects for the October 2000, the October 2001 and the November 2002 monitoring surveys are provided in Figures 1 through 30 of Appendix C. Photographs from the March

2001 surveys were presented in the Results of the March 2001 Survey of Erosion Pins Technical Memorandum (BBL, 2001) and are not presented here. Field notes from the erosion pin surveys are contained in Appendix D.

River Flow Conditions During the Bank Erosion Pin Surveys and the Erosion Pin Study

Flow data from the Kalamazoo River indicate that no exceptionally high river flow events have occurred since pin installation was completed in the fall of 2000. Figures 5 and 6 present the USGS flow data time series since October 2000 for the USGS gages near Allegan and Comstock, respectively. The maximum daily mean flows during the 2-year period were 5,050 cubic feet per second (cfs) on February 15, 2001 at Allegan and 4,230 cfs on February 14, 2001 at Comstock. Based on flow return frequency analysis conducted on USGS flow data collected at Comstock prior to 1998, 4,230 cfs corresponds to approximately the 6-year return flow. By comparison, the 50-year return flow is 6,250 cfs, or approximately 48% greater than the 6-year return flow at Comstock.

Interim Erosion Pin Monitoring Results

Changes in the bank profiles over time were assessed by comparing the results of the March 2001 (2001A survey), October 2001 (2001B survey), and November 2002 (2002 survey) surveys to the baseline survey completed by October 2000 (2000 survey). As described in the erosion pin placement report, the location and elevation of each erosion pin was surveyed over time (see Figures 1 through 3 for pin locations). To provide a general interpretation of results in the river along the length of each impoundment, the results for each set of three erosion pin lines in the vicinity of a sediment sampling transect were classified using one of the following descriptions: minimal change, erosion, sloughing, deposition, or intermittent erosion/deposition. Table 1 summarizes these qualitative observations. Where intermittent erosion/deposition is indicated in Table 1, the direction of change in the river bottom elevation at the toe of the bank varied among surveys, indicating accumulation and periodic erosion of sediments at the toe of the bank in these locations. Where deposition is indicated in Table 1, sediment accumulation over time in the river at the toe of the bank was apparent in the survey results.

Table 1. Summary of Qualitative Observations from Transect Comparisons since October 2000.

Impoundment	Transects	Left Bank* (looking downstream)	Right Bank* (looking downstream)
Former Plainwell Impoundment	EP-57	Erosion and sloughing	Deposition
	EP-60	Minimal change	Deposition
	EP-62	Minimal change and erosion	Minimal change and deposition
	EP-65	Minimal change	Deposition
	EP-67	Minimal change and erosion	Minimal change and erosion
Former Otsego Impoundment	EP-85	Minimal change	Minimal change
	EP-87	Erosion	Erosion
	EP-89	Erosion and intermittent erosion /deposition	Erosion and minor erosion
	EP-90	Erosion and deposition	Intermittent erosion/deposition
	EP-94	Erosion	Minimal change and deposition
Former Trowbridge Impoundment	EP-99	Minimal change	Sloughing and intermittent erosion/deposition
	EP-101	Erosion and deposition	Bank sloughing and erosion
	EP-102	Erosion and sloughing	Minimal change and erosion
	EP-103	Deposition and sloughing	Minimal change and deposition
	EP-106	Erosion	Minimal change

*Note: Summary descriptions of observed bank profile changes at the three erosion pin lines in the vicinity of each transect location; often the individual erosion pin lines showed variable changes over time.

Additional observations and preliminary interpretations from the erosion pin survey data are provided below.

- **Bank erosion is a source of sediment and PCB to the Kalamazoo River in all three of the former impoundments; however, not all areas within the impoundments have experienced erosion over the 2-year period since erosion pin placement.** Sampling has shown that the bank soils and sediments contain concentrations of PCBs. Based on the qualitative descriptions of bank changes over time shown in Table 1, the erosion pin survey results indicate that bank erosion and/or bank sloughing occurred at 40% (4 of 10) of the locations surveyed in the former Plainwell Impoundment, 60% (6 of 10) of the locations in the former Otsego Impoundment, and 70% (7 of 10) of the locations in the former Trowbridge Impoundment.

  Additionally, the survey data indicate that significant deposition has occurred along the toe of the banks in some locations, apparently unrelated to bank soil losses. Figure 7 provides an example of a bank profile from the former Plainwell Impoundment at which deposition occurred in the near shore area at the toe of the bank. Figure 8 shows an example of a bank profile from the former Plainwell Impoundment where bank erosion has occurred. Figure 9 shows an example of a bank profile from the former Plainwell Impoundment where bank sloughing is apparent.

- **There are instances of a high degree of small-scale spatial variability.** This is evident at certain locations by comparing results for the sets of three erosion pin lines spaced 20 feet apart. For example, at the left bank location at transect EP-99 in the former Trowbridge Impoundment, erosion pin lines EP-99BX and EP-99BY show deposition at the toe of the bank and no change in the top of bank or the bank profile. The results for erosion pin line EP-99BZ show significant bank erosion and reduction in the top of bank elevation due to bank soil loss, as well as sediment accumulation at the toe of the bank that may be from bank sloughing or sediment deposition (see pages 64-66 in Appendix A).

- **Relatively high rates of bank erosion are occurring at various locations within each of the three former impoundments (see Table 2).** In the former Plainwell Impoundment at location EP-62AY, soil loss along the entire face of the bank and bank toe occurred. Based on the changes in the top of bank position, the data suggest a rate of bank retreat at this location of 0.68 ft/year over the last two years (see figure on page 14 of Appendix A). At location EP-94AY in the former Otsego Impoundment, a similarly high rate of erosion was measured, with the entire bank face and bank toe retreating at an average rate of 1.17 ft/year over the last two years (see figure on page 56 of Appendix A). In the former Trowbridge Impoundment, at location EP-106AX, soil loss from a more gradually sloped bank was measured. The top of bank location established at the beginning of the survey lost 3.70 ft of soil (measured horizontally) indicating an approximate rate of bank retreat of 1.85 ft/year at this location (see page 85 of Appendix A). Table 2 shows estimated horizontal and vertical bank erosion rates for example transects with vertical changes in the top of bank location greater than 0.5 feet within each former impoundment.

Table 2. Examples of Bank Erosion Rates Where Top of Bank Changes are Greater than 0.5 feet within Each Former Impoundment
(October 2000 through November 2002)

Former Impoundment	Location	Horizontal Top of Bank Change	Vertical Top of Bank Change
Plainwell	EP-62AY	1.36 ft, 0.68 ft/yr	1.22 ft, 0.61 ft/yr
	EP-65AY	0.43 ft, 0.22 ft/yr	0.81 ft, 0.41 ft/yr
	EP-67BX	0.13 ft, 0.07 ft/yr	1.63 ft, 0.82 ft/yr
	EP-67BY	1.55 ft, 0.78 ft/yr	1.83 ft, 0.92 ft/yr
Otsego	EP-87AZ	0.78 ft, 0.39 ft/yr	2.56 ft, 1.28 ft/yr
	EP-89BX	0.62 ft, 0.31 ft/yr	0.64 ft, 0.32 ft/yr
	EP-94AY	2.64 ft, 1.32 ft/yr	2.03 ft, 1.02 ft/yr
Trowbridge	EP-99BZ	1.94 ft, 0.97 ft/yr	1.89 ft, 0.95 ft/yr
	EP-101BX	1.46 ft, 1.23 ft/yr	1.11 ft, 0.56 ft/yr
	EP-101BY	0.45 ft, 0.23 ft/yr	1.24 ft, 0.62 ft/yr
	EP-106AX	3.70 ft, 1.85 ft/yr	0.50 ft, 0.25 ft/yr

- **Visual observations made during the repeat surveys of the erosion pin locations confirm the survey and erosion pin measurements.** Bank sloughing can occur due to several factors, including erosional undercutting, repeated wetting and drying of the banks, and repeated freezing and thawing of the banks. Instances of bank undercutting were observed in the former impoundments by field staff conducting the erosion pin surveys. Wetting and drying causes desiccation cracking of the bank soils leading to calving of blocks of soil from the bank to the river. Repeated freezing and thawing can form fracture planes within the bank soils causing similar loss of relatively large pieces of bank soil to the river. Blocks of sediment that have fallen off the banks were noted along the banks of the former impoundment during the erosion pin surveys. Examples of bank sloughing are evident at locations such as EP-57AZ (page 3 in Appendix A) and EP-103AZ (page 81 in Appendix A). In addition, some of the observations described here are apparent in the photographs of erosion pin transect locations provided in Appendix C.

- **Although bank erosion and bank sloughing was observed during the October 2000 to November 2002 period in which the maximum flow equals the 6-year return flow, larger floods that may occur in the future may represent larger bank erosion potential.** The largest flows that occurred during this period, 4,230 cfs at Comstock, is approximately equal to the 6-year return interval flow. While significant amounts of bank erosion and sloughing were observed, larger rates would be expected during larger flood events.

The bank erosion pin data provide evidence that the banks are a significant continuing source of solids to the Kalamazoo River. Although volumes of materials or the mass of PCBs associated with the losses or gains of materials in the former impoundments were not estimated for this report, these data show that there are locations within each of the impoundments that have lost significant amounts of bank soils potentially containing PCB to the river over the 2-year study period.

References

Blasland, Bouck & Lee, Inc. (BBL). 2000a. *Supplement to the Phase I RI/FS Report - Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site* (Syracuse, NY: October 2000).

BBL. 2000b. *Former Impoundment Erosion Pin Placement Report* (Syracuse, NY: December 2000).

BBL. 2001. *Technical Memorandum – Results of the March 2001 Survey of Erosion Pins* (Syracuse, NY: July 2001).

BBL. 2002. *Technical Memorandum – Results of the October 2001 Survey of Erosion Pins* (Syracuse, NY: March 2002).

Figures

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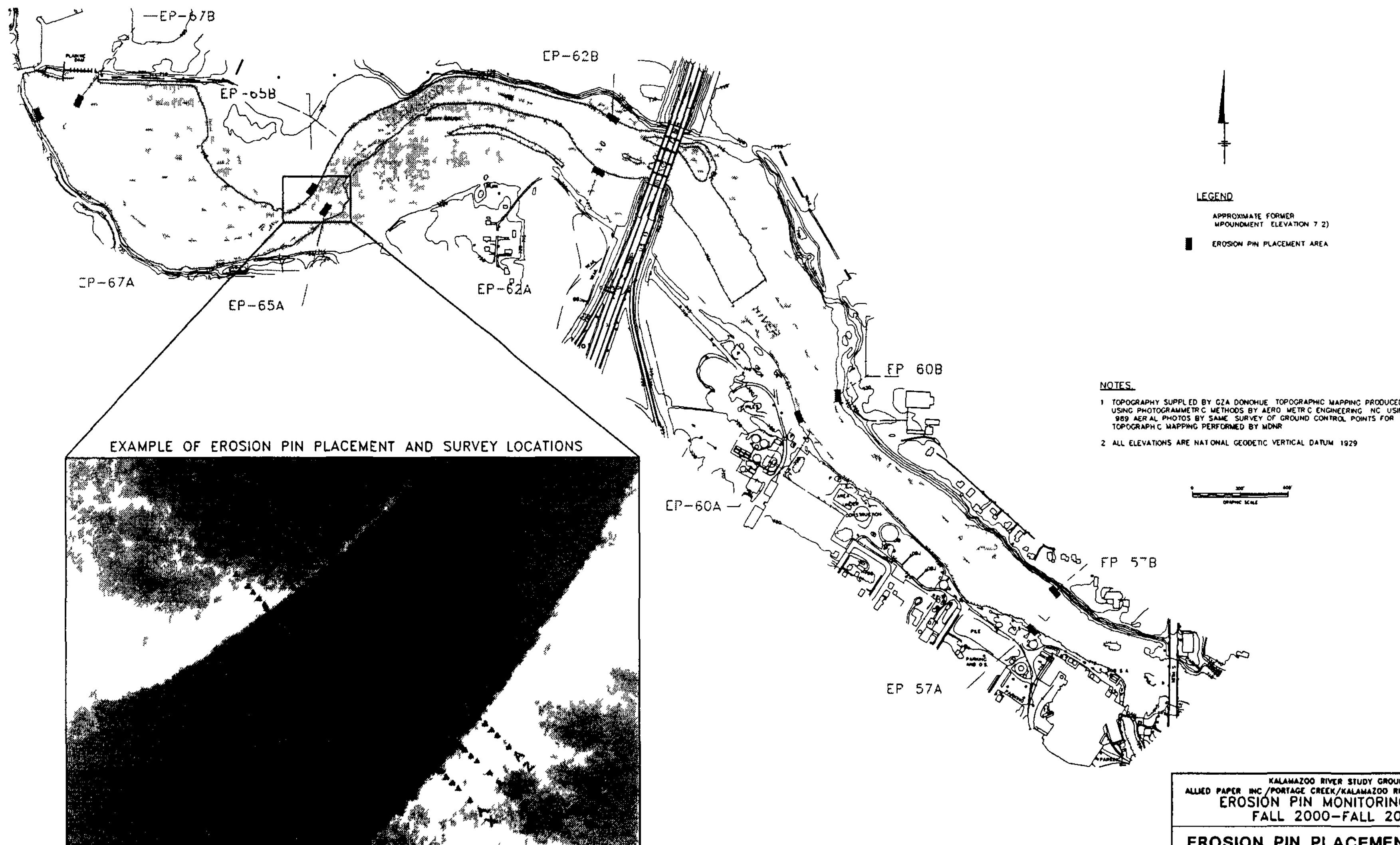

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ALLIED PAPER INC /PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE
EROSION PIN MONITORING DATA
FALL 2000–FALL 2002

EROSION PIN PLACEMENT IN THE FORMER PLAINWELL IMPOUNDMENT

BBL
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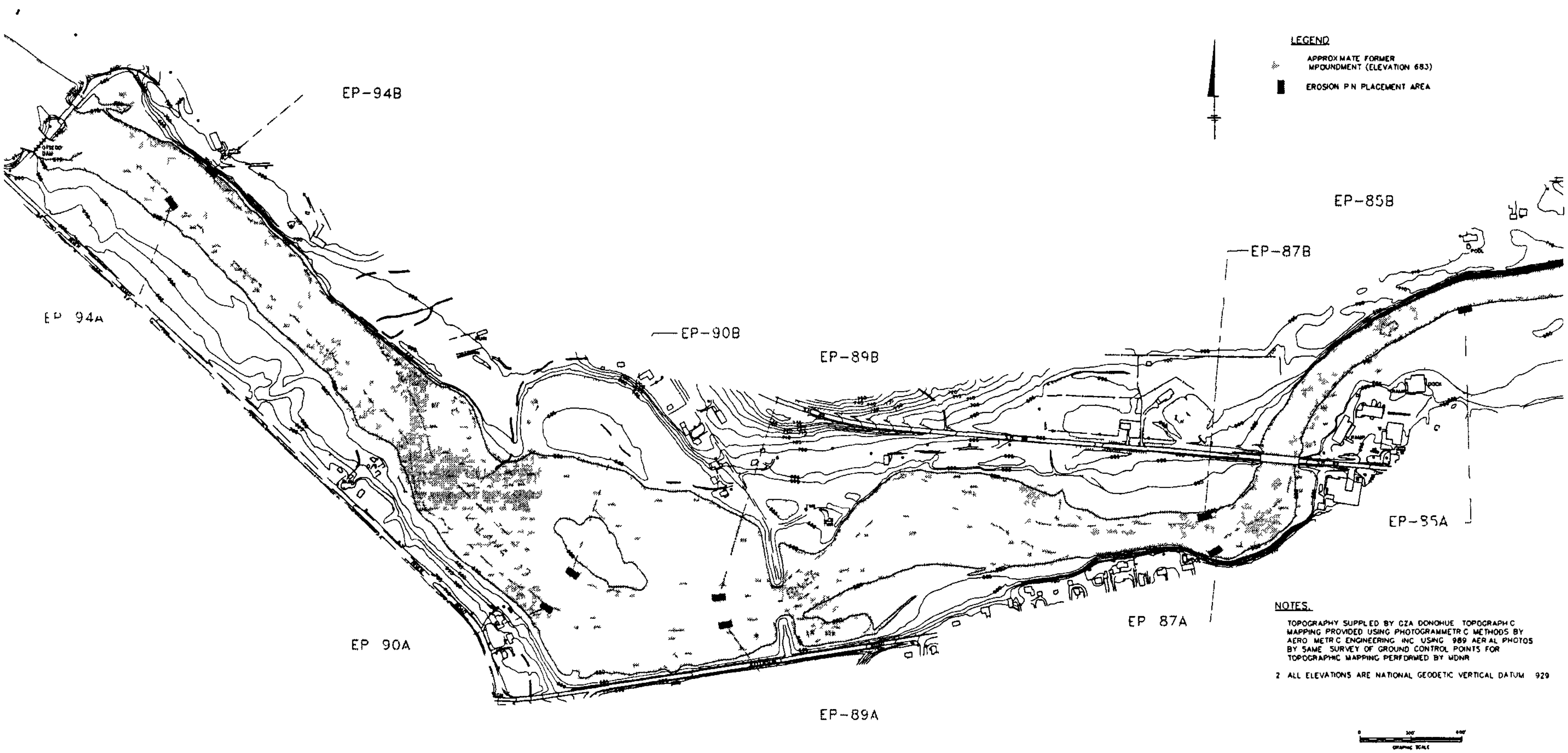
FIGURE 1



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EROSION PIN MONITORING DATA
FALL 2000-FALL 2002

EROSION PIN PLACEMENT IN THE FORMER OTSEGO IMPOUNDMENT

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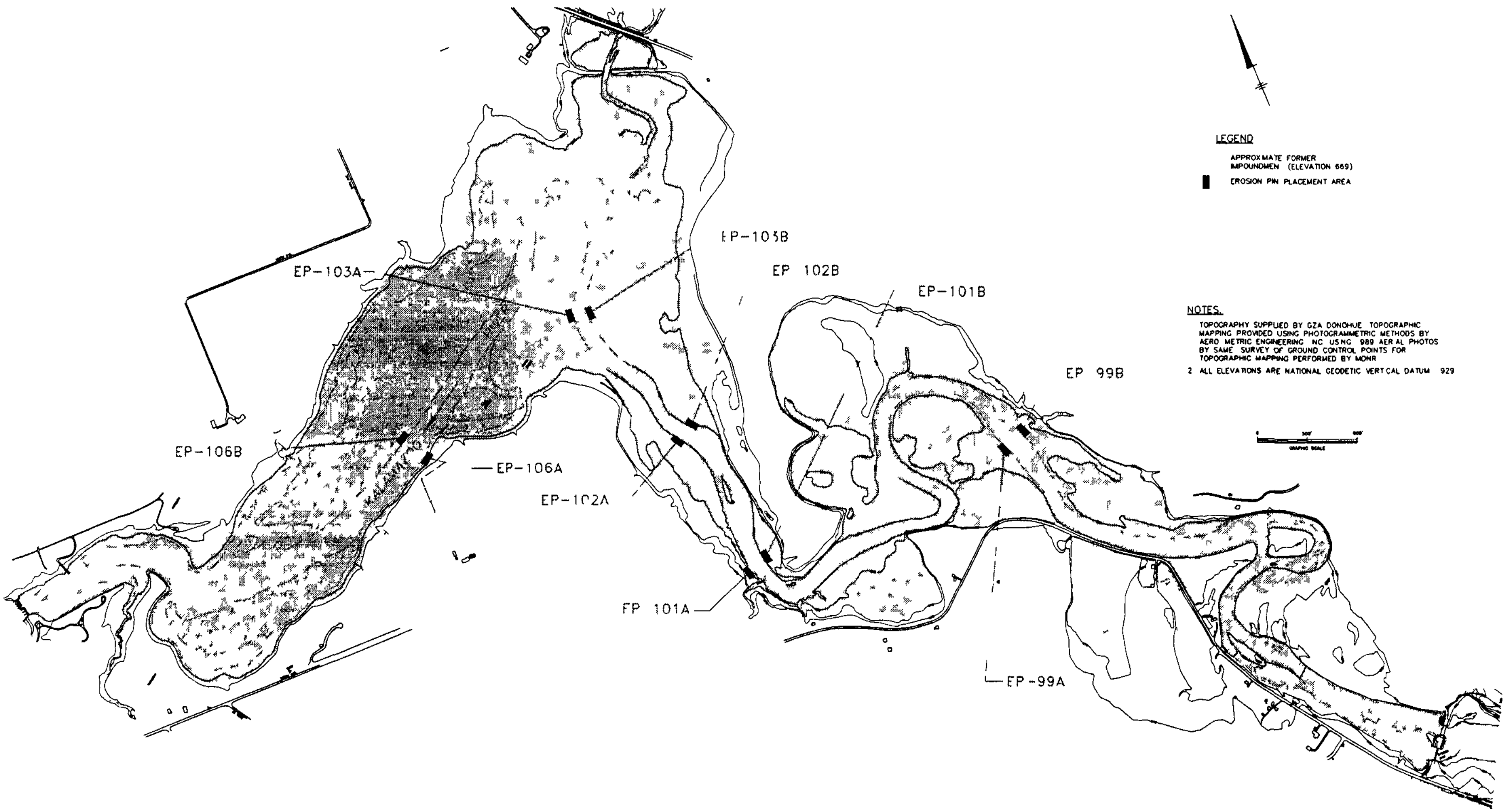
FIGURE 2

ON= OFF=REF
P STD PCP/DL
0 /03/03 SYR 54 KMD GMS KMD
845301 4/84530G02 DWG



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FALL 2000–FALL 2002

EROSION PIN PLACEMENT IN THE FORMER TROWBRIDGE IMPOUNDMENT

BBL
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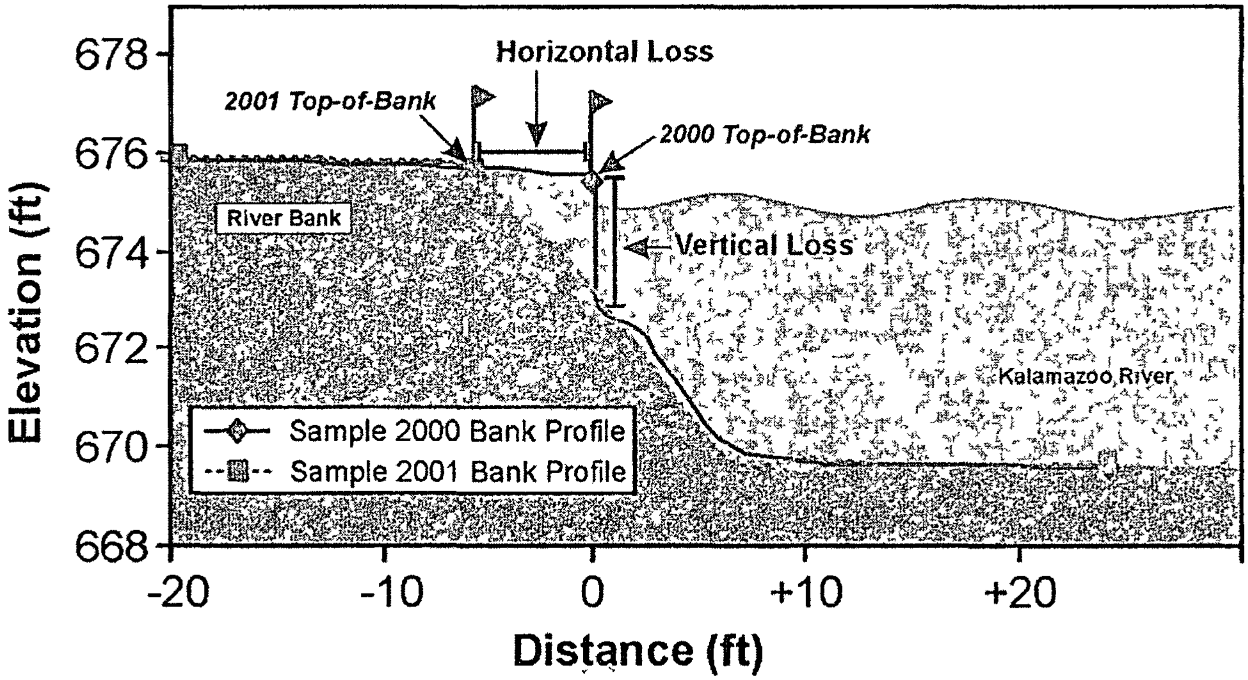
FIGURE
3



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

EXAMPLE OF HORIZONTAL AND VERTICAL BANK LOSS COMPARISON

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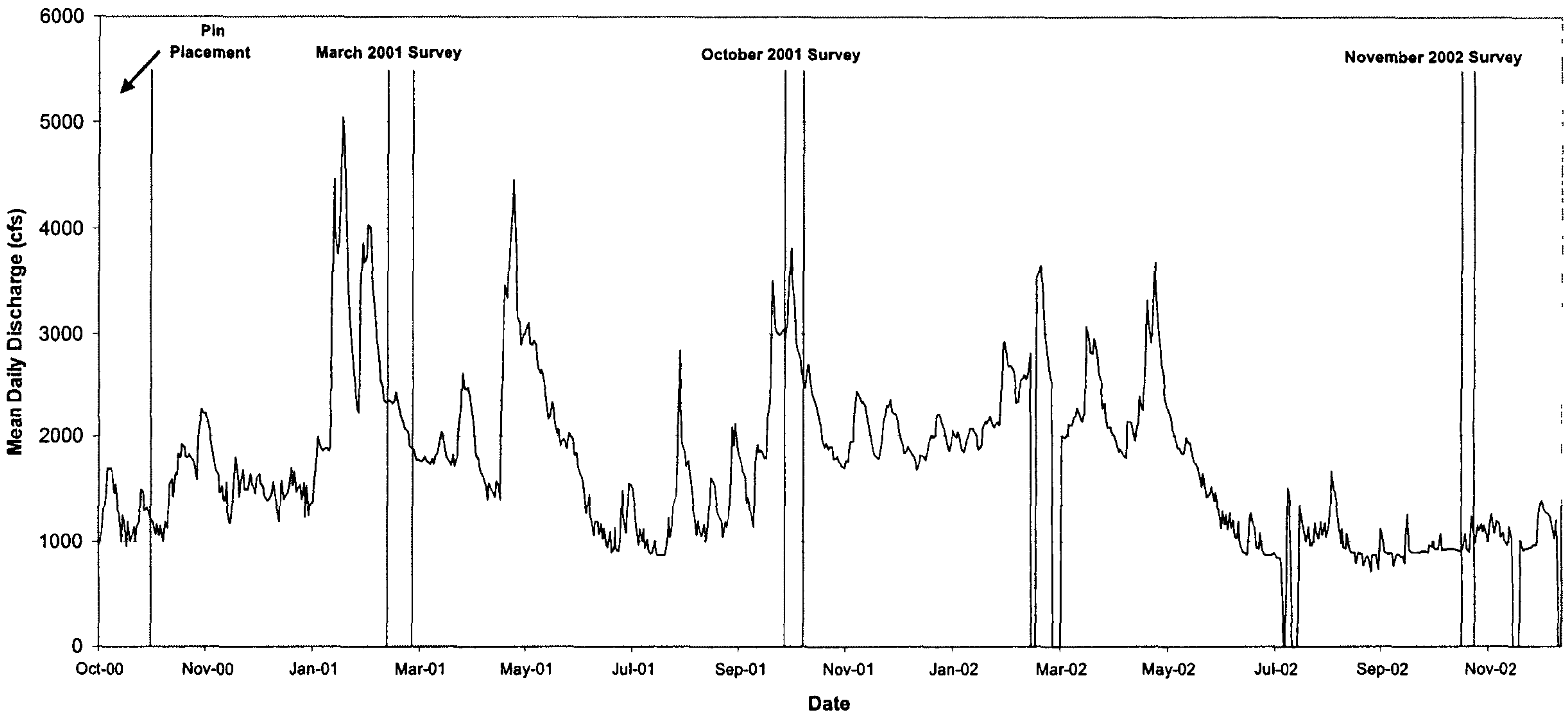
FIGURE 4

01/08/03 SYR D54 DJH
64530114/64530N01 CDR

Kalamazoo River at Allegan
Mean Daily Discharge
2000 - 2002
(based on available provisional data from the USGS Gage 04107850)



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

MEAN DAILY DISCHARGE FOR THE KALAMAZOO RIVER NEAR ALLEGAN, MI

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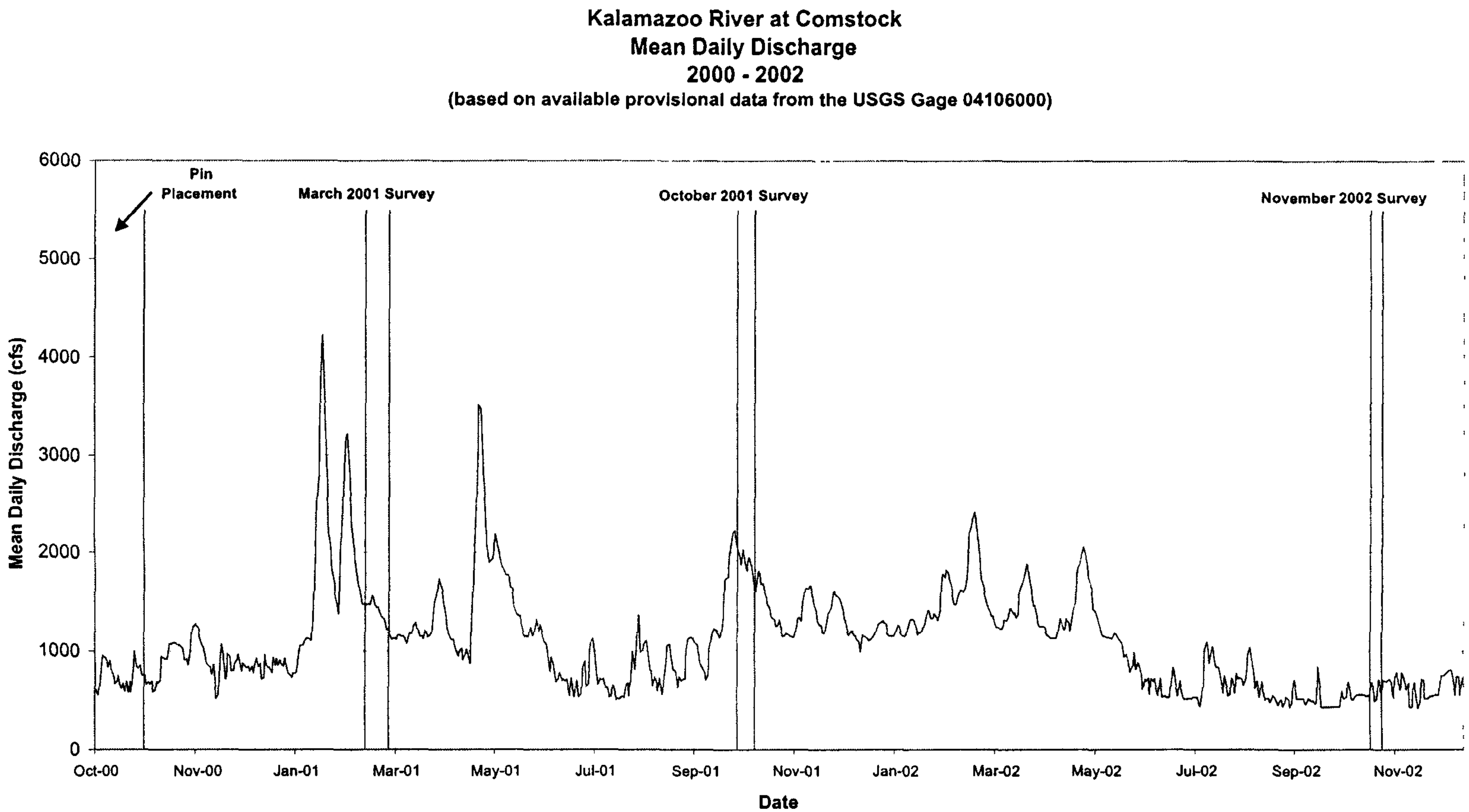
FIGURE
5

01/03/03 SYR-D54-DJH
64530114/64530N02.CDR



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

MEAN DAILY DISCHARGE FOR THE KALAMAZOO RIVER AT COMSTOCK, MI

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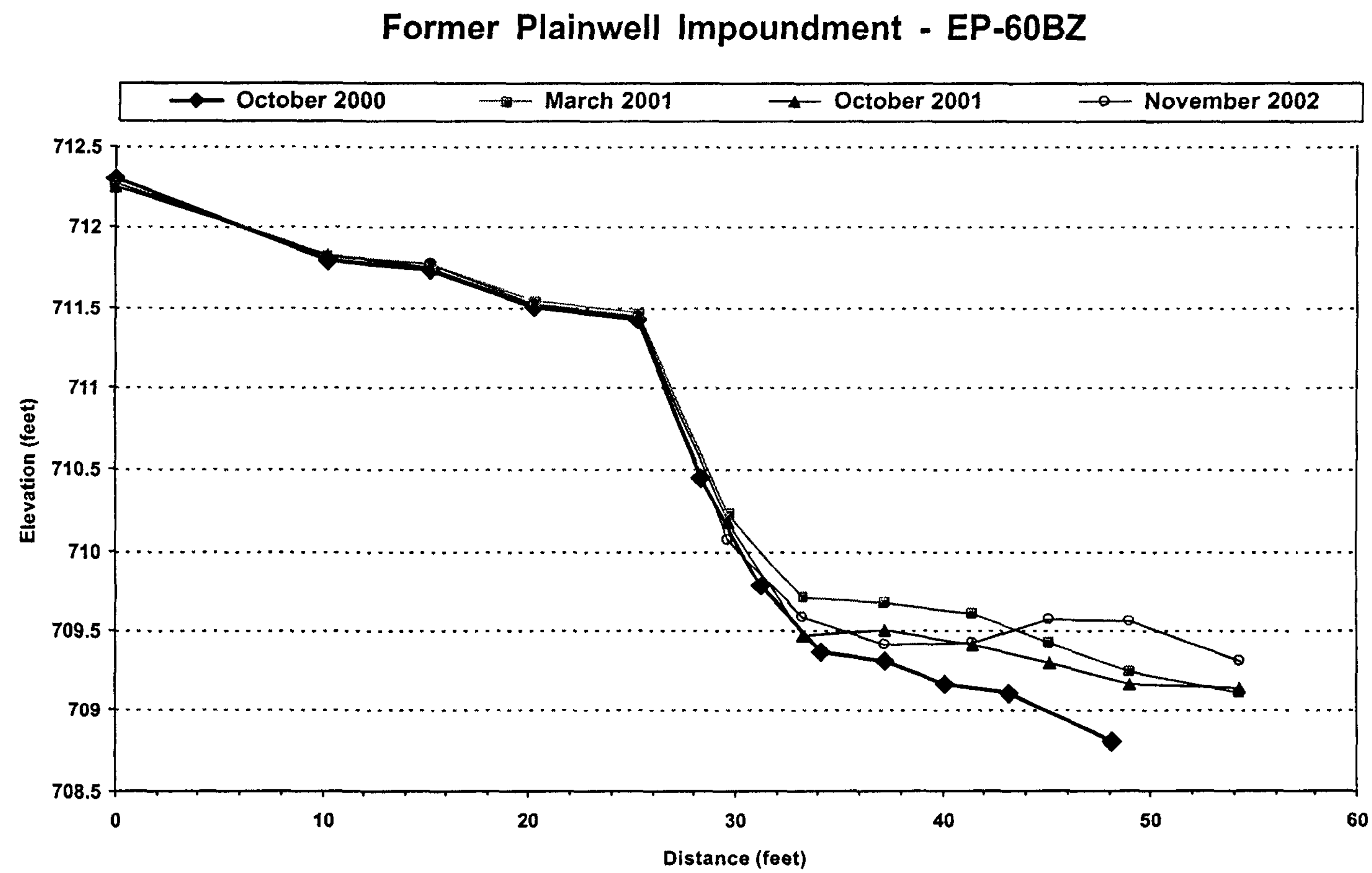
FIGURE
6

01/08/03 SYR-D54-DJH
64530114/64530N03 CDR



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

APPARENT DEPOSITION AT EP-60BZ

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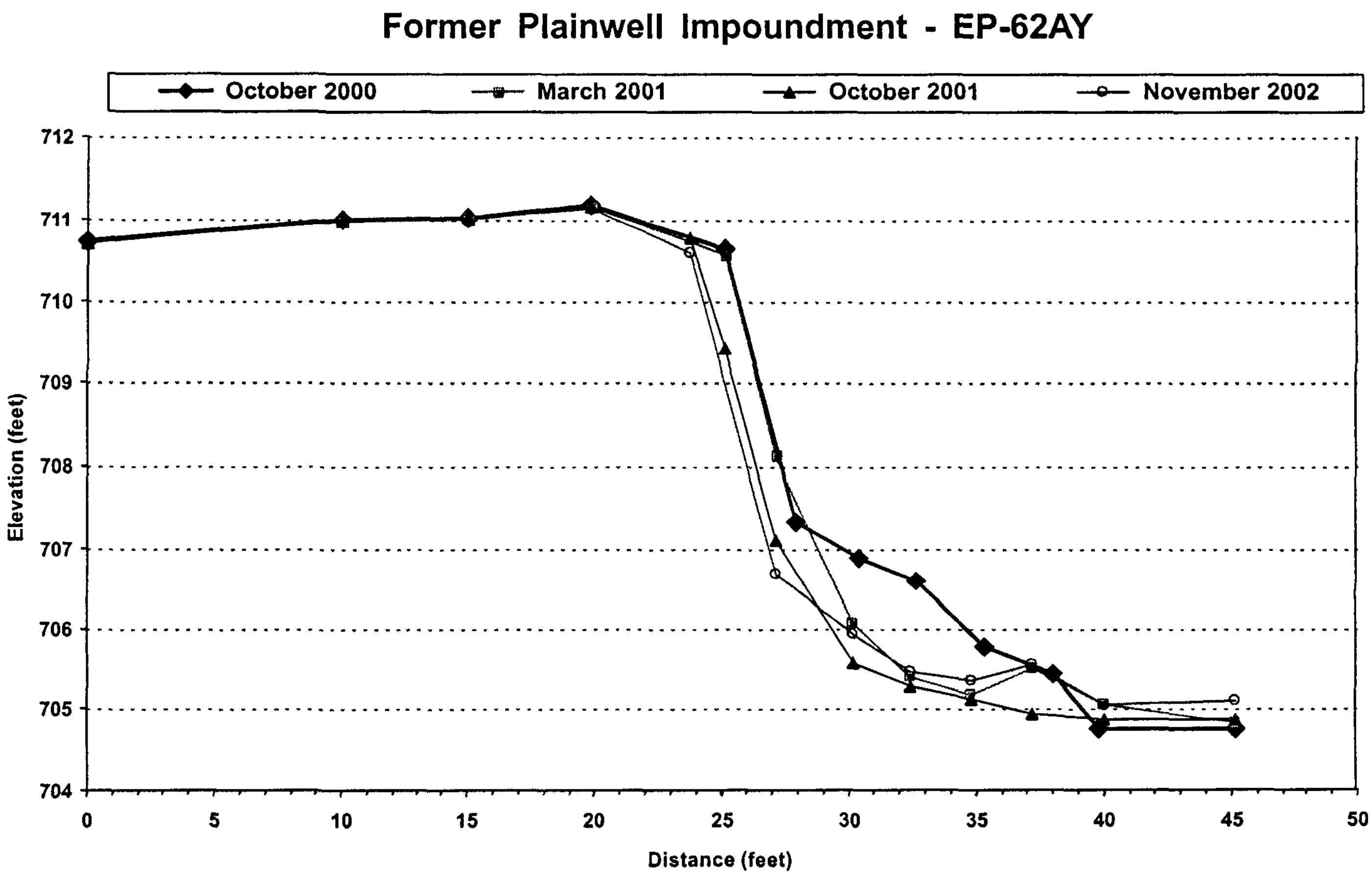
FIGURE
7

01/08/03 SYR-D54-DJH
64530114/64530N04 CDR



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

APPARENT BANK EROSION AT EP-62AY

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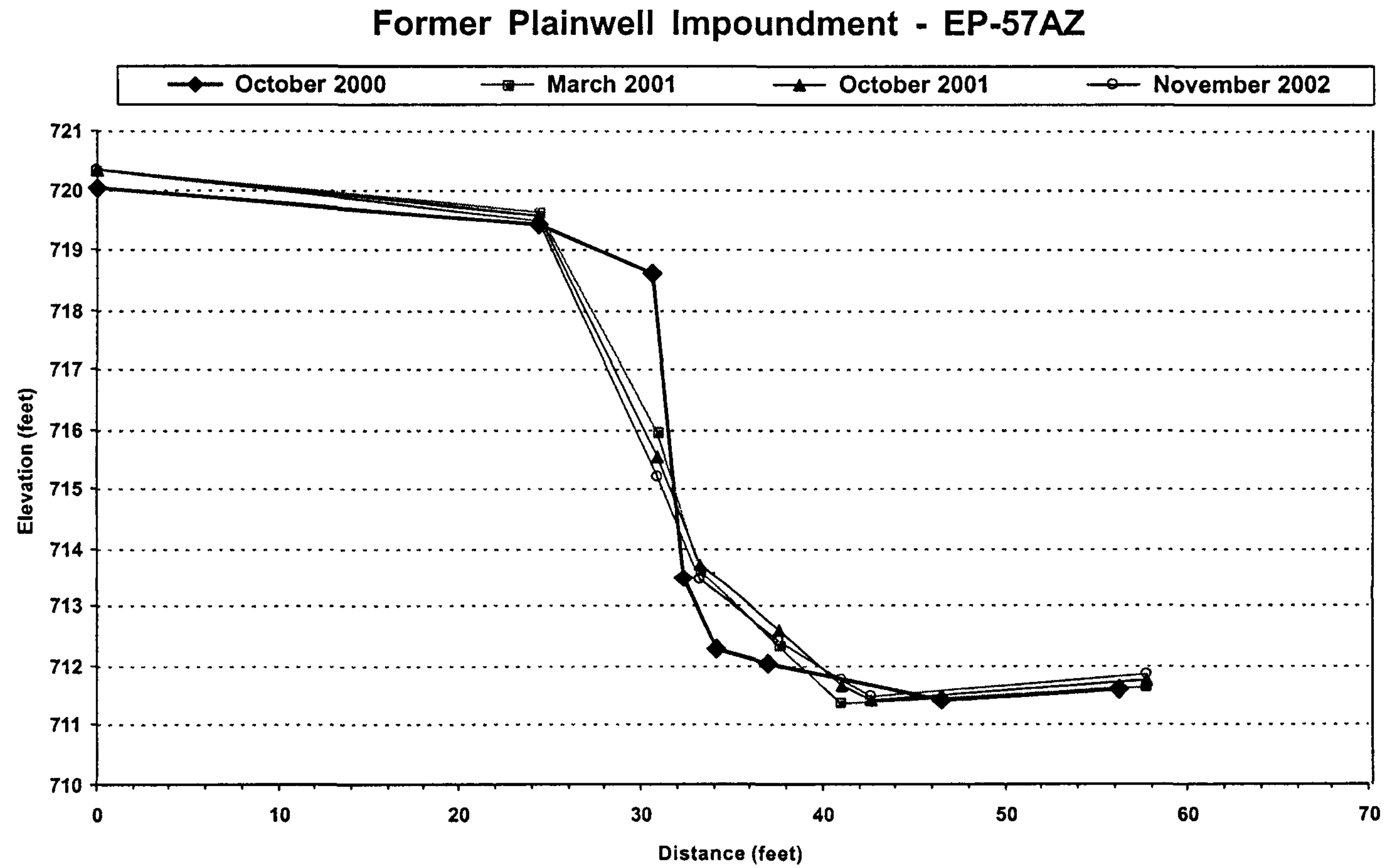
FIGURE
8

01/09/03 SYR-D54-DJH
64530114/64530N05.CDR



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EROSION PIN MONITORING DATA
FALL 2000 - FALL 2002

APPARENT BANK SLOUGHING AT EP-57AZ

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FIGURE
9

01/08/03 SYR-D54-DJH
64530114/64530N06.CDR